Patent claims

1. A method for automatically controlling a production process for the series production of order-specific products,

- the production process comprising a partial process (100.1,..., 100.8),

- a sequence (50) of orders (10.1, 10.2,...) in electronic form for products which are produced in the production process, and a sequence (50) of production objects (20.1, 20.2,...) from which the products are created run through the production process,

- a selection process in which an order of the order sequence and a production object of the production object sequence that match one another are selected,

- the selected production object is processed according to the selected order in the partial process (100.2, 100.3)

- and the selection process and processing are repeated until each order of the order sequence (50) has run through the partial process,

characterized in that

a copy (60) of the order sequence (50) is generated,

an initially empty electronic buffer memory (400.2, 400.3) for orders is created,

in a selection process, whenever the first production object of the production object sequence (70) and the first order (11.1, 11.2,...) of the copy (60) do not match one another, the first order is removed from the copy (60) and stored in the buffer memory (400.2, 400.3),

and, in a selection process, whenever the waiting time of at least one order in the buffer memory (400.2, 400.3) up to this selection process is greater than or equal to a prescribed waiting time limit,

- the order with the greatest waiting time in the buffer memory (400.2, 400.3) and a production object (20.1, 20.2,...) matching it from the production object sequence (70) are selected,

- the selected order is removed from the buffer memory (400.2, 400.3)

- and the selected production object is brought forward to the first place of the production object sequence (70).

2. The method as claimed in claim 1, characterized in that

- a minimal time interval between two selection processes

- and a numerical limit for the maximum number of orders in the buffer memory (400.2, 400.3)

are prescribed

and a value which is less than or equal to the product of the minimal time interval and the numerical limit is prescribed as the waiting time limit.

3. The method as claimed in claim 1 or claim 2, characterized in that

- a maximum run-through time through the partial process, to be guaranteed for all production objects of the production object sequence (70),

- a maximum processing time, applicable to all production objects of the production object sequence (70), as a time interval between when the production object is selected and when the production object leaves the partial process,

- and a maximum time interval between two successive selection processes

are prescribed

and the waiting time limit is prescribed such that the sum of

- the waiting time limit,

- the prescribed maximum time interval

- and the prescribed maximum processing time

is less than or equal to the prescribed maximum run-through time.

4. The method as claimed in one of claims 1 to 3, characterized in that, whenever the waiting time of an order in the buffer memory (400.2, 400.3) has reached or exceeded the waiting time limit,

for each order in the buffer memory (400.2, 400.3), on a trial basis,

- a matching production object is determined,

- a work order for the partial process is generated for the processing of the matching production object for the order,

- how long the implementation of this work order will last is determined

and that order in the buffer memory (400.2, 400.3) for which the sum of the waiting time in the buffer memory and the implementation time determined on a trial basis takes the greatest value is selected.

5. The method as claimed in one of claims 1 to 4, characterized in that

whenever no production object in the production object sequence (70) matches the order with the greatest waiting time and this greatest waiting time is greater than the waiting time limit,

this order is removed from the buffer memory (400.2, 400.3) and marked.

6. The method as claimed in one of claims 1 to 5, characterized in that, whenever

the buffer memory (400.2, 400.3) contains at least one order that matches the first production object of the production sequence (70),

and no order in the buffer memory has a waiting time greater than the waiting time limit,

the first production object and the matching order are selected.

7. The method as claimed in one of claims 1 to 6, characterized in that

- a natural number N is prescribed as the batch size for the processing of production objects in the partial process,

- N orders that can be processed as a batch in the partial process are selected from the copy (60) of the order sequence (50) and/or the buffer memory (400.2, 400.3), and

- N production objects of the production object sequence (70) that match the N orders are selected, brought forward to the first N places of the production object sequence (70) and processed according to the N orders in the partial process.

8. The method as claimed in claim 7, characterized in that

a set of N orders and N production objects matching them is repeatedly selected on a trial basis,

each of the selected sets is assessed with an assessment function, which is based on at least one of the following individual criteria:

- the number of production objects of the production object sequence (70) that are before a production object of the set selected on a trial basis and themselves do not belong to the set,

- the number of orders of the copy (60) of the order sequence (50) that are before an order of the set selected on a trial basis and themselves do not belong to the set,

- the maximum waiting time in the buffer memory (400.2, 400.3) of those of the N orders selected on a trial basis,

- the costs for the processing of the N production objects in the partial process according to the N orders,

- the time requirement for the processing of the N production objects in the partial process according to the N orders,

and the set assessed as the best is actually selected.

9. The method as claimed in claim 7 or claim 8, characterized in that the first N production objects of the production object sequence (70) and N orders matching them are selected.

10. The method as claimed in one of claims 1 to 9, characterized in that

- the selected order is inserted into the copy (60) at the first place

- and the maximum promotion and/or the maximum demotion of the production objects of the production object sequence (70) are determined,

the order sequence (50) being compared with the copy (60) of the order sequence (50).

11. The method as claimed in one of claims 1 to 10, characterized in that the quotient of

- the number of those orders (10.1, 10.2,...) in the copy (50) of the order sequence (60) that are stored in the buffer memory (400.2, 400.3)

- and the number of the orders (11.1, 11.2,...) in the order sequence (50) before the first selection process

is determined.

12. The method as claimed in one of claims 1 to 11, characterized in that

- after the partial process, the production objects run through a further partial process (100.5),

- the selected order is inserted into the copy (60) at the first place,

- a further, initially empty, electronic buffer memory (400.5) for orders is created,

- a further selection process, in which an order of the copy (60) and a production object of the production object sequence (70) that match one another are selected, is carried out for the further partial process (100.5),

- in a further selection process, whenever the first production object of the production object sequence (70) and the first order of the copy (60) do not match one another, the first order is removed from the copy (60) and stored in the further buffer memory,

- in a further selection process, whenever the waiting time of at least one order in the second buffer memory (400.5) up to this selection process is greater than or equal to a prescribed further waiting time limit,

  - the order with the greatest waiting time in the further buffer memory (400.5) and a production object matching it from the production object sequence (70) are selected,

  - the selected order is removed from the further buffer memory (400.5)

  - and the selected production object is brought forward to the first place of the production object sequence (70),

- the selected production object is processed according to the selected order in the further partial process (100.5)

- and the further selection process and processing are repeated until every order of the order sequence (50) has run through the further partial process (100.5).

13. The method as claimed in one of claims 1 to 12, characterized in that

- the production process comprises a further partial process (100.5), which is run through the production objects after the partial process,

- a further selection process, in which an order of the order sequence (50) and a production object of the production object sequence (70) that match one another are selected, is carried out for the further partial process (100.5),

- the selected production object is processed according to the selected order in the further partial process (100.5)

- and the further selection process and processing are repeated until every order of the order sequence (50) has run through the further partial process.

14. The method as claimed in one of claims 1 to 13, characterized in that

- the sequence of the orders in the order sequence (50) is compared with the sequence in which the orders are selected,

  for each order, its relative position in the selection sequence being determined in comparison with the position in the order sequence (50)

- and a sequence quality of the production process is calculated from the relative positions of all the orders.

15. The method as claimed in claim 14, characterized in that, in the calculation of the sequence quality,

- the greatest value of all the relative positions,

- the smallest value of all the relative positions

- and/or the mean value of all the relative positions

is determined.

16. The method as claimed in one of claims 1 to 15, characterized in that

- each order comprises features of the product to be produced order-specifically,
- each production object comprises features which have been manufactured in a previous partial process (100.1) of the production process,
- and, in the check whether a production object and an order match one another, the production object features are compared with a subset of the product features.

17. The method as claimed in claim 16, characterized in that

- a production object and an order are assessed as matching one another
- whenever every product feature of the order that belongs to the selection subset is consistent with all the features of the production object.

18. The method as claimed in one of claims 1 to 17, characterized in that

for each order of the order sequence (50), a data record is created in an electronic database, which record comprises

- a first data field for the position of the order in the order sequence (50) and
- a second data field for the position of the order in the copy (60),

the copy is formed by the second data field of each data record being filled with the respective value of the first data record

and, when the order is selected, the position of the order in the copy (60) is entered in the second data field.

19. The method as claimed in claim 18, characterized in that

each data record comprises an initially empty third data field for the electronic buffer memory,

an order is stored in the buffer memory by the third data field of the data record for the order being filled with an identification of the buffer memory,

and an order being removed from the buffer memory by the third data field being emptied.

20. The method as claimed in one of claims 1 to 19, characterized in that

- the production process comprises a sorting buffer (500.3, 500.5)

- and, when the selected production object is brought forward to the first place of the production object sequence (70), all the production objects of the production object sequence (70) before the selected production object are stored in the sorting buffer (500.3, 500.5).

21. The method as claimed in claim 20, characterized in that

- the sorting buffer (500.3, 500.5) comprises a designated maximum number of available places for production objects

- and, whenever free places are not available in the sorting buffer (500.3, 500.5) for every production object that is arranged in the production object sequence (70) before the selected production object,

  - the selection of the order and of the production object is reversed

  - and the order is removed from the buffer memory (400.3, 400.5) and marked.

22. An apparatus for automatically controlling a production process as claimed in one of claims 1 to 21, which comprises

- a device for selecting an order of the order sequence (50) and a production object of the production object sequence (70) that match one another,

- an electronic buffer memory (400.2, 400.3, 400.5) for orders,

- a device for generating a copy (60) of the order sequence (50)

- and a device for selecting the customer order with the greatest waiting time in the electronic buffer memory (400.2, 400.3, 400.5).

23. A computer program product which is loaded directly into the internal memory of a computer and comprises software sections with which a method as claimed in one of claims 1 to 21 can be performed when the product runs on a computer.

24. A computer program product which is stored on a computer-readable medium and which has computer-readable programming means which cause the computer to perform a method as claimed in one of claims 1 to 21.